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ABSTRACT

In light of substantial declines in enrollments in liberal arts mathematics courses in two-year colleges, this paper looks at some of the reasons for these declines and suggests ways of revitalizing the traditional "great ideas" mathematics course. First, a brief outline is presented of the history of liberal arts mathematics, focusing on the questioning of the relevance of particular courses during the 1960's; the dramatic drop in liberal arts mathematics enrollments from 72,000 in 1975-76 to 19,000 in 1980-81; and the increased student interest in skills that would lead to jobs. Next, the future of mathematics in liberal arts education is discussed, and a curricular reorganization is proposed, including basic skills courses, courses for career-oriented students, and survey courses covering arithmetic processes, geometry, algebra, statistics, logic, and computer technology applied to algorithmic processes, concepts, generalizations, and problem solving. Next, traditional instructional approaches are contrasted with alternative methods emphasizing hands-on experience in the laboratory and the community. Finally, the potential of liberal arts mathematics is discussed in terms of meeting the competency needs of the 1980's by combining the main features of the "great ideas" mathematics course and basic skills training. A sample course outline is appended. (HB)

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LIBERAL ARTS MATHEMATICS - CORNERSTONE OR DINOSAUR?

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ABSTRACT

Liberal arts education in general, and liberal arts mathematics in particular, has a long history in American education, but since 1972 enrollments in liberal arts mathematics in the two-year colleges have dropped from 72,000 to a low of 19,000 in 1981. This paper explores some of the reasons for this decline and then looks toward the future and asks the question, "Can or should the old 'great ideas' mathematics course be revitalized to fit the needs of the students in the 1980s?" The thesis put forth in this paper is that it can be revitalized, but only if it takes on new form and includes a new orientation. The old liberal arts course will not only need to be modified to fit the career-oriented student, but also will need to satisfy the competency requirements now being imposed by several states. This new course will need to build basic skills in a survey-type course covering arithmetic, algebra, and geometry, as well as topics from logic, probability, statistics, and computer technology.

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History of Liberal Arts Mathematics

Liberal arts education can be defined as "that part of education which seeks to make people reflective and responsible; to relate art, music, and literature to their lives, to increase their understanding of the past, present, and future of the society of which they are members; and to bring them into the culture. Its roots are in the Greek ideal of liberal education, of educating people for participation in the polity."[1]

The concept of liberal arts education began in the medieval Greek universities with the study of grammar, rhetoric, logic, music, astronomy, geometry, and arithmetic, and included those ideas which were considered essential for the learned person. Later the curricula were expanded to include the classical languages, philosophy, and the natural sciences. By the nineteenth century the physical and social sciences were also included. During the nineteenth century, scholars began to associate themselves with specific academic disciplines and liberal arts took on a disciplinary form.

In 1924, Koos studied the curricula in fifty-eight public and private junior colleges and found the liberal arts totaling three fourths of the curricula. Within the curricula, mathematics accounted for 7.4% of the

[1]Arthur M. Cohen and Florence B. Brawer, The American Community College (San Francisco: Jossey-Bass Publishers, 1982), p. 283.

total offerings in those junior colleges.[2] In collegiate mathematics, liberal arts courses were developed to survey the underlying ideas of mathematics, and then to apply them to a wide variety of mathematical settings, such as algebra, geometry, probability, statistics, and logic. This emphasis in liberal arts courses continued through the 1960s and developed into what have been called the "great ideas" mathematics courses. These courses were built around the great ideas which revolutionized modern thinking, the great ideas which created major areas of study in the mathematical sciences, as well as many of the great ideas of famous mathematicians. Therefore, these liberal arts courses often had a definite historical flavor, and were aimed toward "developing an appreciation of mathematics," rather than toward teaching specific manipulative skills.

The Present State

In the early 1960s, most two-year colleges had a liberal arts orientation, serving as feeders to four-year colleges. In the 1960s we heard the students tell the schools "You have no authority to tell me what to study!" and the educators of the times agreed that their programs were not relevant. In the late 1960s, the word relevant meant applicable to living a more democratic, peaceful, communal, and ecological life. However, by the mid-1960s, there had been considerable change in the emphasis of the courses. New programs were introduced in the occupational/technical areas -- in data processing, dental hygiene, electronics, practical nursing,

[2]E. L. Koos, The Junior College, (Minneapolis: University of Minnesota Press, 1924), p. 29.

automotive mechanics, accounting, bricklaying, carpentry, and police and fire science.

But during the 1970s it became obvious that many persons with liberal arts backgrounds were unable to parlay their education into jobs, or to incorporate their education into the jobs at which they were employed. There was a cry for meeting student needs and providing skills that would lead to employment. The consumerism of education in the 1970s became skill oriented and between 1975 and 1980 there was a 74% drop in liberal arts mathematics enrollments (see Table 1).

TABLE 1 ENROLLMENTS IN LIBERAL ARTS MATHEMATATICS IN TWO-YEAR COLLEGES IN THE UNITED STATES[3]

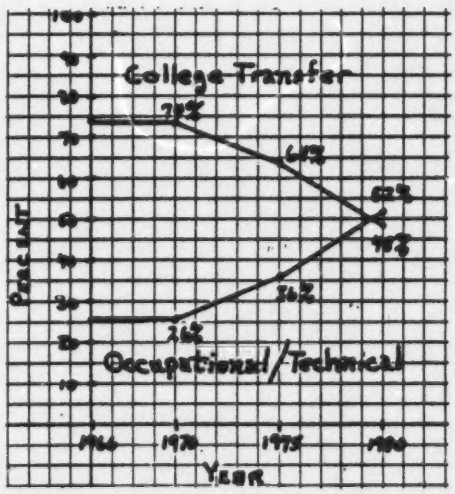
Year	Enrollment
1966-67	22,000
1970-71	57,000
1975-76	72,000
1980-81	19,000

Among the reasons for the decline in liberal arts mathematics courses was the desire on the part of the student to obtain a "real job" and the corresponding specific required mathematics courses from algebra through calculus, the increased demand of specialization, the decline of the number of persons entering elementary education, and the mood of the 1960s. By the early 1970s the catchword became individualism and we were no longer preparing people to become educated members of a free society, but instead were preparing them solely for a job. In an article on

[3]James T. Fey, Donald J. Albers, and Wendell H. Fleming, Undergraduate Mathematical Science in Universities, Four-Year Colleges, and Two-Year Colleges, 1980-81, Volume VI (Washington: Conference Board of The Mathematical Sciences, Report of the Survey Committee, Vol. VI, 1981), p. 83.

liberal education, C. J. Hurn summarized the feeling of the time: "Lacking any consensus as to the content of liberal education, and lacking confidence in their prescriptive authority -- as the catchphrase puts it, 'to impose their values upon others' -- educators were in a weak position to mount a defense of anything other than an educational supermarket, where customer preferences, in the middle and late 1970s at least, were clearly for the more immediately utilitarian and basic items on the shelf."[4] Currently, full-time-equivalent enrollments in occupational/technical programs lead enrollments in college transfer programs. This is a reversal of the trend prior to 1970 as shown in Figure 1.

Figure 1 Percentage of Full-Time-Equivalent Enrollments



Source: Projections of Education Statistics to 1986-87 and The Conference Board of Mathematical Sciences questionnaire data for 1980 (Washington: The Conference Board of Mathematical Sciences, Report of The Survey Committee, Vol. VI, 1981), p. 83.

[4] C. J. Hurn, "The Prospects for Liberal Education: A Sociological Perspective," Phi Delta Kappan, 1979, Vol. 60, No. 9, p. 632.

As you can see from Figure 1, less than half of two-year college students are now enrolled in transfer programs. This reversal in the type of students being served by two-year colleges has led to a reevaluation of the traditional liberal arts program in general, and to a reassessment of liberal arts mathematics in particular.

Look Toward the Future

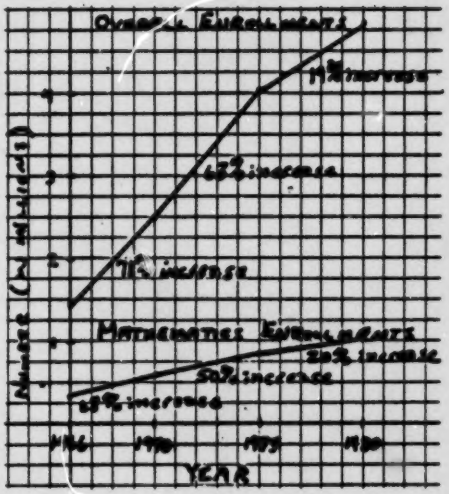
Given the decline (and some are saying demise) of liberal arts mathematics in the United States, what is its future? Should the course be scrapped and replaced by the new wave of courses, such as discrete mathematics, finite mathematics, computer programming, or even by the "main line" mathematics courses of algebra, trigonometry, and calculus? Can the old "great ideas" mathematics course be revitalized (or resurrected) to fit the needs of the students in the 1980s?

The enrollments in mathematics in general are increasing at the same rate as college enrollments (see Figure 2), and therefore we can conclude that students who, in the past, enrolled in liberal arts courses are now enrolling in other mathematics courses.

A reorientation of the liberal arts curriculum is definitely necessary. It should serve not only as a stimulus and vehicle for those adults who are returning to school looking for more than an interlude between high school and a profession, but it should also serve those who are looking for basic skill-building mathematics courses. At a time when students are saying, "Don't bother me with something that is not part of

Figure 2 Enrollments in Two-Year Colleges

Year	Total Students	Mathematics
1966	1,464,099	348,000
1970	2,499,837	584,000
1975	4,069,279	874,000
1980	4,825,931	1,048,000



Source: 1981 Community, Junior, and Technical College Directory, American Association of Community and Junior Colleges, One Dupont Circle, N.W., Washington, D.C. 20036 and The Conference Board of Mathematics Sciences, Report of the Survey Committee, 1981, op. cit., p. 74.

the basic required curriculum," can we tell them, "Yes, manipulations and equation-solving skills are important, but mathematics is much more than manipulations and problem solving"? To do away with a historically oriented great ideas mathematics course would allow the pendulum to swing way too far in the other direction. We need, instead, a new type of liberal arts course, one that not only focuses on the great ideas of mathematics, but also integrates those great ideas into a course satisfying a list of basic mathematical competencies as well. If the liberal arts course is to survive, it will have to be modified to fit the career-oriented student. It will need to be modified to satisfy the competency requirements now being imposed by several states.

Consider, for example, the College Level Academic Skills Test (CLAST) in mathematics which is being required for graduation in the state of Florida. These requirements of basic skills in arithmetic, geometry, algebra, statistics, logic, and computer technology are applied to specific skills in the following categories:

I. Algorithmic Processes

II. Concepts

III. Generalizations

IV. Problem Solving

These basic competencies are not built around the old "great ideas in mathematics" of the traditional liberal arts course. But what course in the traditional mathematics curriculum is best able to meet these needs? In California, two-year colleges must soon certify that their graduates have demonstrated a basic competency in mathematics. Are these requirements of basic competency to be interpreted as separate courses such as algebra or geometry, or should there be an integrated course developed to meet these requirements? Perhaps the liberal arts course of the 1960s and 1970s can satisfy the needs of the future by assuming a dual role. This dual role is discussed by Cohen and Brawer:

> For the sake of their students and communities, the community colleges should maintain a place in higher education, but a reorientation is required. One area of possible integration of the liberal arts with career education is a merger of principles stemming from both the humanities and the sciences. Technology is ubiquitous; students would have little difficulty understanding generally how the history, politics, ethics, sociology, and philosophy of science and technology affect their world. Those who would be more than mechanics would attend to the fundamental assumptions undergirding what scientists and technologists do.[5]

[5]Arthur M. Cohen and Florence B. Brawer, The American Community College (San Francisco: Jossey-Bass Publishers, 1982), p. 304.

In attempting to fit the liberal arts great ideas course into the dual role of maintaining basic skills within an environment that provides for reading, reflecting, and discussing, the colleges should not neglect the contrasting modes of teaching the liberal arts and the occupational courses. The traditional liberal arts mathematics course is taught by an instructor in a room with chairs, a chalkboard, and perhaps an overhead projector. If the class size permits, the instructor interacts with the students to stimulate the thought process and set up a dialogue of learning. On the other hand, the occupational courses have required labs, shops, and equipment. Have we simply accepted the idea that career teaching costs more because it has evolved from a history of apprenticeships in work settings? Instructors of these occupational courses maintain that their students must practice the craft, and not merely talk about it. For many years we have asserted that "mathematics is not a spectator sport," but what does that mean for schools and instructors of the future? Should we continue to teach liberal arts mathematics at a chalk board, or should we move out into the real world to give our students a variety of hands-on experiences in the lab and in the community? For example, computer assisted instruction is now common in many parts of the country. Community projects involving business and industry can be designed for or by students of these new liberal arts courses in order to help the students gain firsthand experience in working with business and industry. How does mathematics relate, for example, to banks and banking? Can students taking this type of course be used to assist in the gathering of demographic or other information useful to city or state governments? How can computers be integrated into everyday activities? Can we

demonstrate the great ideas of mathematics in a problem-solving, skills-oriented setting? Can we change the modes of teaching liberal arts mathematics in the future as it assumes the new function of meeting both basic competencies and perpetuating the great ideas of mathematics?

Do we, the mathematical community, let the great ideas mathematics course of the past become the dinosaur of the 1990s, or do we change, modify, and build it into a basic skills course which does meet the competency requirements of the 1980s? There is a need for building basic skills in a survey-type course covering arithemtic, algebra, and geometry, as well as topics from logic, probability, statistics, and computer technology. We can use such a course as the cornerstone for meeting the job-oriented demands of today's, and tomorrow's, students. The appendix gives an outline for such a course.

A Sample Course Outline

How can a single course incorporate basic mathematical competencies with the great ideas of the old liberal arts course presented with a historical perspective? The following list of topics is only one possibility and is offered for further discussion.

I. Logic
   - A. Sets
     1. Unions, intersections, complements
     2. Combined operations
     3. Venn Diagrams
   - B. Inductive Reasoning and Patterns
     1. Arithmetic sequences
     2. Geometric sequences
     3. Series
   - C. Deductive Reasoning
     1. Fundamental connectives: and, or, not
     2. Additional connectives and logical translation
     3. Proof

II. Arithmetic
   - A. Historical Numeration Systems
     1. Repetitive system (such as the Egyptian)
     2. Positional system (such as the Babylonian)
     3. Hindu-Arabic system
   - B. Natural Numbers
     1. Properties
     2. Exponents
   - C. Integers
   - D. Rational Numbers
     1. Fractions
     2. Decimals
     3. Percents
   - E. Ratio and Proportion
   - F. Irrational Numbers
     1. Square roots
     2. Pythagorean theorem
   - G. Real Numbers

III. Algebra
   - A. Mathematical Systems
   - B. Algebraic Simplification
   - C. Linear Equations
   - D. Linear Inequalities
   - E. Systems

IV. Geometry
- A. Geometrical Figures
- B. Systems of Measurement
  - 1. U. S. system
  - 2. Metric system
- C. Measuring Length and Area
- D. Angles
- E. Euclidean Geometry
  - 1. Proofs
  - 2. Parallel lines
- F. Volume and Surface Area
- G. Coordinate Geometry
- H. Lines and Half-planes

V. Probability and Statistics
- A. Combinatorics
  - 1. Counting
  - 2. Permutations
  - 3. Combinations
- B. Probability Models
- C. Conditional Probability
- D. Mathematical Expectation
- E. Frequency Distributions
- F. Descriptive Statistics
  - 1. Mean, median, mode
  - 2. Variance, standard deviation
- G. The Normal Curve
  - 1. Standard normal
  - 2. z-scores
- H. Sampling

VI. Computer Technology
- A. History of Computers
- B. Calculators
- C. Uses and Misuses of Computers
- D. BASIC Programming
- E. Loops and Repetitive Processes

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